Construction of an alpha-irradiation-setup for cells*

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Introduction

In the framework of the GREWIS project, the influence of Radon alpha particles is studied on biological objects. But for cell exposure the hit probability of individual cells is too small at therapeutic Radon concentrations and the non-hit cells will cover the affected cells. Therefore cells have to be exposed directly to low energy alpha particles from a radioactive source with higher doses. Consequently an alpha-irradiation-setup has been established using Americium-241 with a half life time of 432,2 years. Am-241 decays under the emission of alpha-particles with an energy of 5,486 MeV and gamma-radiation with 59,5 keV. Because of the low range of these high LET-particles a short distance between source and target is demanded [1]. In addition biocompatibility of all materials used has to be tested in experiments for cell growth, plating efficiency, X-ray cell killing and distribution of nucleus diameter.

Design

In the current design, a large area Am-241 source of 3,5 cm in diameter and an activity of 25 MBq is inserted in the basis of the irradiation chamber. Because of the high source activity only short but precise exposures are required. In order to guarantee a precise exposure, we interposed a fast mechanical shutter between the Am-241-source and the target. This shutter from the Sutter Instrument Company shields the alpha-particles entirely and is able to open within 12 ms. Thus we achieve to deposit nearly exactly the wanted dose. In figure 1 a crossection through the setup is given showing the Am-241 source, the shutter and a ring with mylar foil having a gap of only 2,7 mm between the source and the cells. Figure 2 shows the current version of the setup. To maintain this short distance, cells cannot grow under normal conditions in a petri dish or cell cultur flask but require to be seeded on a 2 μm thick foil. This mylar foil is attached to rings of stainless steel with an inner diameter of 35 mm.

Results

In order to confirm that the measured effects result from the alpha-irradiation and are not due to the special culturing conditions, several radiobiological experiments were performed. One of them is the comparison of cell survival after X-ray irradiation of CHO-K1 cells, cultivated in T25 cell cultur flask or on the mylar foil. From the results shown in figure 3 it can be derived that the clonogenic survival of CHO-K1 cells is not different comparing mylar foil and culture flasks.

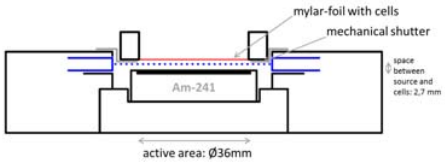

Figure 1: Crossection through the setup

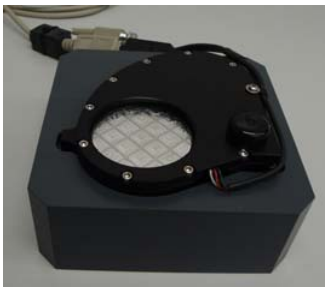

Figure 2: Picture of the Setup and the closed shutter

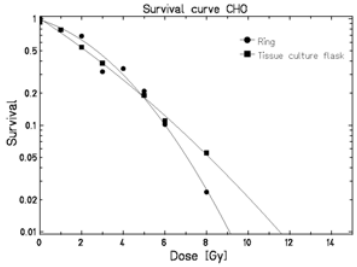

Figure 3: Survival of CHO cells after X-ray irradiation growing on mylar foil or culture flasks

References

[1] Lindsay A Beaton et. al., Development and characterization of an in vitro alpha radiation exposure system, Phys. Med. Biol. 56 (2011) 3645-3658

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